

# A review of direct current cardioversions for atrial arrhythmia

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## SUMMARY

**The risk of arterial embolism is well recognised following Direct Current Cardioversion (DCC) for atrial fibrillation although the use of prophylactic anticoagulation remains controversial.**

***Aim:* To determine the risk of arterial embolism post-cardioversion and which factors predict successful cardioversion and maintenance of sinus rhythm.**

***Materials and Methods:* A retrospective study was carried out of all cardioversions performed for atrial fibrillation and atrial flutter at the Waveney Hospital Ballymena, during 1989-1993. A review of medical records and electrocardiograms was carried out to assess demographic characteristics, co-existent diseases, anticoagulant status, echocardiographic features and characteristics of the arrhythmia. Embolic events in the six weeks post-cardioversion were noted.**

***Results:* The study included 157 cardioversions in 109 patients. The predominant arrhythmia was atrial fibrillation (n=108, 69%). Three of 109 patients (2.7%) experienced embolic complications, none of whom had anticoagulation prior to the procedure. No risk factors for cerebro-vascular disease or significant valvular heart disease were present. Return to sinus rhythm was achieved in 143 (91%) procedures. Increasing coarseness of atrial fibrillation was associated with a non-significant trend towards successful restoration of sinus rhythm (p=0.18). Recurrence of the original arrhythmia was predicted by an increase in coarseness of atrial fibrillation (p<0.05).**

***Conclusions:* These findings indicate that embolic complications can occur in patients undergoing DCC with normal echocardiographic dimensions, and that prophylactic anticoagulation should be considered in all patients. Coarseness of atrial fibrillation may be used as a guide to predict the chance of successful cardioversion and of the likelihood of maintaining sinus rhythm once this has been achieved.**

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## INTRODUCTION

Atrial fibrillation is the commonest sustained arrhythmia. Chronic atrial fibrillation is associated with a doubling of mortality,<sup>1</sup> largely due to an increase in the incidence of stroke.<sup>2</sup> The potential benefits of a return to sinus rhythm are a reduction in the risk of systemic embolisation and an improvement in haemodynamics secondary to the return of atrial mechanical function.<sup>3</sup>

Return to sinus rhythm may occur spontaneously or may be achieved by chemical or electrical cardioversion. Direct Current Cardioversion (DCC) in atrial fibrillation is a successful, safe procedure and should be considered for all patients regardless of aetiology. DCC is known to be highly effective for the immediate conversion of

atrial fibrillation to sinus rhythm.<sup>4</sup> The risk of embolism following DCC for atrial fibrillation is well recognised but the use of routine prophylactic anticoagulation remains somewhat controversial. Certain factors, such as duration of atrial fibrillation, left atrial size as assessed by M-mode echocardiography and aetiological associations may be predictive of a successful

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restoration of sinus rhythm, although these have not been confirmed by Dittrich.<sup>5</sup>

We reviewed the results of 202 cardioversions for atrial fibrillation and atrial flutter over a five year period to assess further the need for prophylactic anticoagulation. In addition, we have attempted to determine factors predicting the risk of thrombo-embolism post-cardioversion and also those parameters predicting successful cardioversion and maintenance of sinus rhythm once this had been achieved.

#### **MATERIALS AND METHODS**

Between 1st January 1989 and 31st December 1993, 202 elective DCC procedures were undertaken in 116 adult patients (82 male) with atrial fibrillation or atrial flutter as the primary arrhythmia. Cardioversions in which atrial fibrillation or atrial flutter were present for less than 48 hours and cardioversions in which anticoagulant status was indeterminate were excluded from subsequent analysis.

All cardioversions were carried out in the Coronary Care Unit under intravenous sedation with midazolam (usual dose 5-10 mgs). A series of synchronised direct current shocks of increasing energy was delivered starting with 50 Joules, and increasing incrementally until sinus rhythm was achieved or 360 Joules was reached. Pre- and post-cardioversion 12-lead electrocardiograms were available to verify heart rhythm.

The medical records were reviewed for demographic characteristics and coexistent diseases (ischaemic heart disease, valvular heart disease, hypertension, diabetes mellitus or cerebro-vascular disease). Electrocardiographs were examined to confirm heart rhythm prior to DCC and to determine the duration of the arrhythmia. In patients with atrial fibrillation the "coarseness" of atrial electrical activity was assessed subjectively and determined to be "coarse", "intermediate" or "fine", depending on the baseline atrial electrical activity and mean "f" wave cycle length. In addition, left atrial size, left ventricular end-diastolic diameter and the presence or absence of valvular heart disease were noted in those patients in whom echocardiography had been performed. Anticoagulant status was recorded and an International Normalised Ratio greater than 1.5 was considered therapeutic. Suspected embolic events in the subsequent six weeks were recorded.

#### **STATISTICS**

Values, where applicable, are given as mean (SD). Group comparisons of categorical variables were made using the Chi-square test. Continuous variables were compared by using the Mann Whitney U-test. A value of  $p < 0.05$  was considered significant.

#### **RESULTS**

Two hundred and two procedures in 116 patients were identified during the study period. Forty-five cardioversions were excluded from the study on account of cardioversion performed within 48 hours of the onset of the arrhythmia ( $n=38$ ) or indeterminate anticoagulant status ( $n=7$ ). The study group therefore consisted of 157 procedures in 109 patients. In 22 (14%) cardioversions prophylactic anticoagulation with oral warfarin had been prescribed prior to the procedure.

Of the 109 patients, 77 (71%) were male and their ages ranged from 17 to 86 years (mean 65.0 (11.1) years). Seventy-five patients required cardioversion on a single occasion and the remaining 34 patients accounted for the other 82 cardioversions included in the study. The predominant rhythm disturbance requiring cardioversion was atrial fibrillation (atrial fibrillation in 108, atrial flutter in 49 cardioversions). Concomitant ischaemic heart disease was present in 31 patients (28%), mitral valve disease in 33 patients (30%), hypertension in 24 patients (22%), diabetes mellitus in 4 patients (4%) and a history of prior cerebro-vascular accident in 3 patients (3%). Mitral valve disease was significantly more prevalent in the anticoagulated group ( $p < 0.05$ ) whereas ischaemic heart disease was significantly more prevalent in the group not receiving anticoagulation ( $p < 0.05$ ). There was no significant difference in anticoagulant status for the sub-groups with hypertension ( $p=0.75$ ), diabetes mellitus ( $p=0.33$ ) or previous cerebro-vascular disease ( $p=0.33$ ) (Table 1).

The duration of the arrhythmia ranged from 48 hours to two years. The duration was less than eight days in 80 cardioversions (51%), eight to 28 days in 40 (25%), 29 days to one year in 36 (23%) and greater than one year in one cardioversion. Two patients had prosthetic aortic valves and one patient had both mitral and aortic prostheses. Echocardiographic data was available in 52 patients (48%) in the study group. The mean left atrial size was 49.9 (6.2) mm (range 36-61 mm).

When the arrhythmia had been present for less than 30 days the mean left atrial size was 49.8 (5.9) mm compared to 50.3 (7.3) mm when present for more than 30 days ( $p=0.89$ ). The mean left

ventricular end diastolic diameter was 56.2 (10.1) mm when the arrhythmia was present for less than 30 days, compared to 56.6 (7.5) mm when present for more than 30 days ( $p=0.98$ ).

TABLE I

*A comparison of risk factors present for cerebro-vascular disease between the groups of patients undergoing cardioversion with and without prophylactic anticoagulation*

	<i>Patients undergoing DCC with prophylactic anticoagulation (n=18)</i>	<i>Patients undergoing DCC without prophylactic anticoagulation (n=91)</i>	
Ischaemic heart disease	1	30	$p<0.05$
Mitral valve disease	10	23	$p<0.05$
Hypertension	3	21	$p=0.75$
Diabetes mellitus	1	3	$p=0.33$
Previous cerebro-vascular disease	0	3	$p=0.33$
No risk factors	3	11	

#### EMBOLIC PHENOMENA

Cerebral embolic events occurred within six weeks of DCC following two of 89 procedures performed for atrial fibrillation and one of 46 procedures performed for atrial flutter, undertaken without anticoagulant prophylaxis (Figure 1). The patients were aged 55, 56, and 63 years (mean 58 years). The arrhythmias were present for 7, 10 and 50 days (mean 22 days). These patients had no co-existent risk factors for cerebro-vascular events. Echocardiographic data were available in two of these patients in whom the left atrial size, left ventricular end-diastolic diameter and left ventricular function were normal. Neither had significant valvular heart disease; one had mild mitral regurgitation and the other had mitral valve prolapse. One patient had a transient right hemiparesis and right homonymous hemianopia and was prescribed aspirin. The other two patients experienced a left hemiparesis and both were prescribed warfarin following CT brain scan confirming an ischaemic infarction. No fatalities resulted from these embolic events.

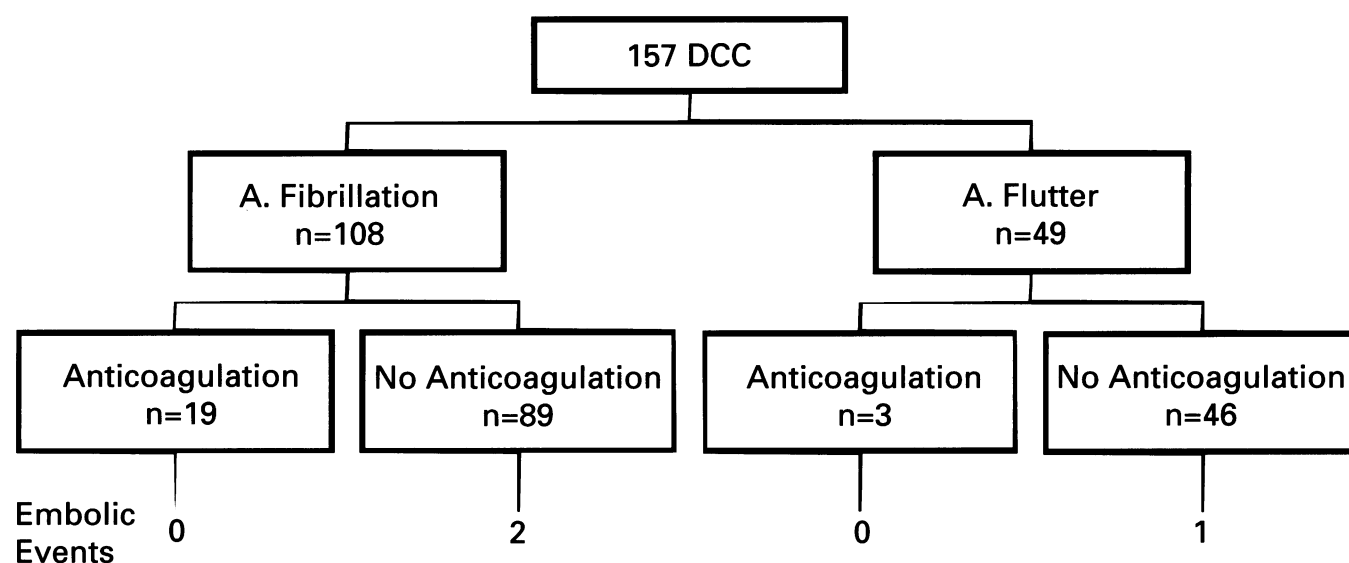
#### SUCCESSFUL CARDIOVERSION

Immediate restoration of sinus rhythm was achieved in 143 (91%) of the 157 cardioversions

performed. In patients who were successfully cardioverted to sinus rhythm the mean left atrial size was 49.9 (5.9) mm whereas in patients whose cardioversions were not successful the mean left atrial size was 49.2 (9.7) mm ( $p=0.73$ ). In patients who were successfully cardioverted, the mean left ventricular end-diastolic diameter was 56.1 (9.8) mm whereas in patients whose cardioversions were not successful it was 58.2 (4.0) mm ( $p=0.73$ ). Increasing coarseness of atrial fibrillation was associated with a successful restoration of sinus rhythm. All 19 patients with coarse atrial fibrillation were successfully cardioverted compared to 36 of 41 (88%) with intermediate atrial fibrillation and 30 of 36 (83%) of those with fine atrial fibrillation ( $p=0.18$ ). Age, duration of the arrhythmia, left ventricular end-diastolic diameter and aetiology were not predictive of successful restoration of sinus rhythm.

Energy requirements in successful cardioversions for atrial flutter were significantly lower than those required for atrial fibrillation. Sixty-six (69%) of 96 successful cardioversions for atrial fibrillation required  $\leq 200$  Joules whereas 42 (89%) of 47 successful cardioversions for atrial flutter required  $\leq 200$  Joules ( $p<0.001$ ). Energy

**Figure 1**  
Summary of 157 cardioversions reviewed with relation to the number of embolic events which occurred.



requirements for those patients with coarse atrial fibrillation were significantly lower compared with those required for intermediate or fine atrial fibrillation ( $p=0.014$ ). Table II shows the energy requirements for 96 cardioversions for coarse, intermediate and fine atrial fibrillation. One cardioversion for atrial fibrillation had no record of the energy required for successful cardioversion; eleven pre-DCC electrocardiograms were unavailable for analysis.

**TABLE II**

*Energy Requirements for the subgroups of Atrial Fibrillation undergoing Successful Cardioversion (n=96)*

Energy (J)	Coarse n(%)	Intermediate n(%)	Fine n(%)
50,100J	8(42)	1(2)	7(19)
150, 200J	9(47)	26(63)	15(42)
300, 360J	2(11)	14(35)	14(39)
	19(100%)	41(100%)	36(100%)
		$\chi^2=8.47$	$p=0.014$

#### RELAPSE RATES

Following successful restoration of sinus rhythm in 143 cases, recurrence of the original arrhythmia occurred in 75 cases (52%). The mean time to relapse was 217 days (range 1 day to 45 months). At one month 25 (17%) patients were found to have relapsed, compared to 53 (37%) at six months. In patients who subsequently reverted to their original rhythm the mean left atrial size was 50.7 (5.9) mm compared to those who remained in sinus rhythm in whom the mean left atrial size was 48.8 (5.9) mm ( $p=0.43$ ). In patients who subsequently reverted to their original rhythm the mean left ventricular end-diastolic diameter was 55.8 (8.2) mm compared to those who remained in sinus rhythm in whom the mean left ventricular size was 56.4 (11.7) mm ( $p=0.9$ ).

Seven of 19 cardioversions for coarse atrial fibrillation resulted in a recurrence of the original rhythm compared to 20 of 36 for intermediate and 17 of 30 for fine atrial fibrillation ( $p<0.05$ ).

Ischaemic heart disease was the aetiological factor in 13 of 75 cardioversions which were followed by a recurrence of the original rhythm, compared to 23 of 68 cardioversions in which sinus rhythm was maintained ( $p<0.01$ ). Although a higher number of patients with mitral valve disease, hypertension and unknown aetiology experienced

a recurrence of the original rhythm, these differences did not reach a significant level. The age of the patient and the duration of the arrhythmia were not predictive of relapse. The effect of anti-arrhythmic agents on relapse rates was not examined.

## DISCUSSION

Synchronised electrical cardioversion for atrial fibrillation and atrial flutter may be complicated by systemic embolisation. This has been estimated to occur in up to 7% of patients.<sup>6</sup> The atrial arrhythmia most likely to be associated with embolic events is atrial fibrillation,<sup>7, 8</sup> although one of three patients developing cerebral thromboembolism in our study had been cardioverted for atrial flutter.

Although it has been suggested that patients with atrial fibrillation should receive anticoagulation prior to undergoing direct current cardioversion,<sup>4, 8</sup> there has been a lack of consensus on such treatment prior to the period included in this study. Recently it has been recommended that anticoagulation should be given for three weeks before and four weeks after DCC for atrial fibrillation of more than 48 hours duration.<sup>9</sup> Data is sparse on the incidence of embolism after cardioversion for specific arrhythmias. Lown, in 1967, reported a 1.2% incidence rate of embolisation after reviewing 456 cardioversion attempts in which none of the patients were anticoagulated.<sup>4</sup> In 1969 Bjerkelund and Orning reported that cardioversion without anticoagulation resulted in a 6.8% incidence rate of embolism, compared with a significantly lower rate of 1.1% with anticoagulation, following successful cardioversion.<sup>10</sup> Mancini and Weinberg reviewed cardioversions over a 10 year period and found no embolic events in the group prescribed anticoagulation, whereas 7% of the group without anticoagulation had embolic complications.<sup>11</sup> Our 2.1% incidence rate of embolic events after successful cardioversion for atrial fibrillation and atrial flutter is higher than other reports.<sup>12-15</sup>

Atrial fibrillation of long duration is a well documented risk factor for stroke.<sup>16</sup> It has been recommended<sup>7, 8</sup> that patients with atrial fibrillation of short duration (<1 week) do not need anticoagulation before undergoing cardioversion. In our three patients suffering cerebral thromboembolism following DCC the

arrhythmia had been present for 7, 10 and 150 days respectively.

It remains unclear how long anticoagulation therapy should be continued after cardioversion. Mechanical atrial activity may take several weeks to resume as shown by Manning who assessed patients by means of serial Doppler echocardiography. They found that peak "A" wave velocity did not return to normal until three weeks after cardioversion in patients who maintained sinus rhythm.<sup>17</sup>

In our series of patients we were able to cardiovert 91% (143 of 157) of patients to sinus rhythm. This is similar to results published by Dalzell.<sup>18</sup> Our findings show that smaller left atrial size is not a useful factor in determining which patients are more likely to be successfully cardioverted. Zipes reports that the only important predictor is the duration of atrial fibrillation.<sup>19</sup> The duration of the arrhythmia was not shown to be a significant predictor in our study. We have identified increasing coarseness of atrial fibrillation as a useful predictor of successful restoration of sinus rhythm.

Without further treatment there is a high rate of relapse following successful cardioversion. The influence of anti-arrhythmic agents was not considered in this review. Sinus rhythm was maintained in 118 of 143 cases (82%) at one month and 90 of 143 cases (63%) at 6 months which compares favourably with those of Dittrich<sup>5</sup> who has reported rates of 69% and 58% at 1 and 6 months respectively. Useful and safe prophylaxis of atrial fibrillation has been demonstrated in selected groups of patients using anti-arrhythmic drugs from different classes, although a metanalysis of randomised control trials in the use of quinidine has indicated an increased total mortality.<sup>20, 21</sup>

Atrial fibrillation is a common arrhythmia that is associated with significant morbidity and mortality. Direct current cardioversion should be considered in all patients regardless of aetiology since initial success rates are high. Our findings indicate that embolic complications can occur in patients undergoing direct current cardioversion without prophylactic anticoagulation who have normal echocardiographic findings and no risk factors for cerebrovascular events. We therefore recommend that prophylactic anticoagulation should be considered in all patients with atrial fibrillation or atrial flutter of >1 week's duration

prior to attempted cardioversion. Anticoagulation should be given for 4 weeks prior to and, at least, 4 weeks following elective cardioversion. Coarseness of atrial fibrillation may be used as a subjective guide to predicting the probability of achieving and maintaining sinus rhythm. The high relapse rates following successful cardioversion remain problematic and the role of prophylactic anti-arrhythmic drugs and non-pharmacological measures remains to be established in these patients with recurrent atrial arrhythmias.

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